Ph.D. Title Proposal

on

An Efficient Credit Card Fraud Detection Model Using Deep Learning Techniques

Submitted in partial fulfillment of the requirement
for the award of the Degree of

Doctor of Philosophy

in

Information Technology

by

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under the guidance of

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August 2024

PROPOSAL FOR TOPIC APPROVAL TO BE SUBMITTED TO THE UNIVERSITY OF MUMBAI FOR THE DEGREE OF **Ph.D. (SCIENCE AND TECHNOLOGY)** IN THE SUBJECT OF **INFORMATION TECHNOLOGY**

Title of Topic	:	An Efficient Credit Card Fraud Detection Model Using Deep Learning Techniques
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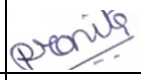
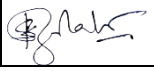
Signature of Student	:	
Signatue of the Research Supervisor	:	

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Statement by the Candidate

I wish to state that the work embodied in this synopsis titled “An Efficient Credit Card Fraud Detection Model Using Deep Learning Techniques” forms my own contribution to the work carried out under the guidance of Dr. Savita Dinesh Sangam at the Shah and Anchor Kutchhi Engineering College,Mumbai. I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission.

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Introduction

Today, credit cards are among the most widely used payment options in India and Abroad. Credit card usage is to pay for something in a store. The consumer pays with a physical card that they carry with them at all times. An unauthorized entity has to obtain the card in order to engage in fraud during this transaction. Financial losses will occur if the user is not aware that their card has been lost. The thieves were apprehended using the victims' credit card information. The use of this technique might lessen fraudulent transactions. Each credit card user is given a special code that includes details about the purchase, the amount spent, and the date of the most recent transaction. Fraud is thought to be anything that doesn't follow this pattern. These are the financial concerns, and the consequences may be multiple. Fraud is the use of deceit to gain financial security. The use of a credit card is more probable to result in effective and focused fraud since there are more people using online credit card purchases as a result of consumers' increased internet usage.

Online shopping and other online activities, such as online banking and credit cards, are becoming increasingly popular after COVID 19 pandemic [1] [2].Only when the fraud has already taken place does the cardholder realize it. Credit card larceny poses a threat to users, cardholders, and corporate assets alike. The quantity of money lost due to fraud increased in recent years, according to card-holders, retailers, and ATM card acquirers transactions at ATMs .Various types of frauds that can happen while swipes at retail outlets, at the time of withdrawing money from ATM ,at the time of online transfer.

The amount of transactions that don't require a physical credit card has increased as e-commerce has become more prevalent. These are the easiest to fake because there isn't any tangible evidence, such as a sign or PIN. Fraudsters have a higher propensity for adapting to change and aren't afraid to change their behavior to lessen the chance of being detected. Adaptability is also required of anti-fraud systems. Credit card fraudsters are caught using a two-step process: first, suspicious management practices are identified; next, a fraud investigation is conducted to determine whether any actual fraud has occurred. It's possible for a computer program to handle the first part, but the rest needs to be done by hand.

Significance of Study

This report considers the latest statistics for credit card frauds that had been reported in India and other countries. According to these statistical findings globally, card fraud losses were recorded at $ 33.5 billion in 2022, up from $ 28.4 billion in 2020 and $ 27.9 billion in 2018.(Nilson, 2023) [3] The overall amount of fraudulent card transactions in the EU decreased by 7 % from 2020 to 2021, with 1.53 billion in card transactions detected as fraudulent (ECB, 2023). 93 % of fraudulent charges in 2024 included credit cards issued in the United States that were still in the owners' possession. Card-not-present (CNP) fraud is a type of fraud that cost$ 174 million in lost revenue in 2023 (Security, 2024; FBI, 2023). According to the Federal Trade Commission (2023), there were 368,379 reports of fraud involving internet shopping in 2023, with damages totaling $ 392 million.

In India according to the latest reports from RBI published in Times of India [4] Credit card and online frauds have increased from 425 % to Rs.1,457 crore FY24 Rs. 277 crore in the period of 1 year ago. According to RBIs annual report, private sector banks have reported the maximum number of frauds. In volume terms, the majority of frauds have occurred in the digital payments (card /

Internet) category. In FY22 banks reported 3596 cases of credit card amounting 155 crore and this number increased to 6699 cases with the value of 277 crore in FY23.This is represented in following Figure 1.

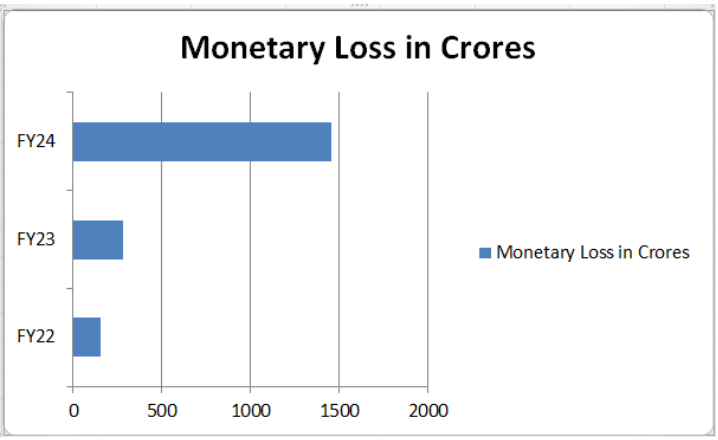

Figure 1: Monetary loss in India reported by RBI published in Times of India

Aim of the Research

The primary objective of the study is to identify credit card transactions that are fraudulent. For the purpose of identifying unauthorized credit card transactions, a variety of deep learning techniques along with explicit techniques for data pre-processing will be used. As data preprocessing plays a major role in classification algorithms. The effectiveness of each technique will be evaluated, and graphs and numbers will also be provided. Ensemble learning approach will be applied for the purpose of classification and early detection of fraudulent transactions.

Research Objectives

The key objective of this work is to identify fraudulent transactions by doing predictive analysis using deep learning techniques on the dataset used to detect credit card fraud. Using predictive models, the focus is on identifying whether a transaction falls under the normal or fraudulent class. Some objectives are given below:

- To explore major issues related to credit card fraud detection and explore the potential of various Deep learning techniques and strategies for Credit card fraud detection.
- To propose ensemble system for detecting credit card fraud.
- To enhance model interpretability contributing to fraud detection decisions.
- To explore hyper parameters in the early detection of credit card frauds.

Related Work

Credit card fraud detection is a danger that requires real-time identification and classification of suspected fraud instances prior to the approval or rejection of the transaction. For the identification and categorization of data related to credit card fraud, many writers offered various methodologies. There are several classification and fraud detection algorithms for credit card detection in this connected study.

Various machine learning algorithms have been implemented for identification of fraudulent transactions like logistic regression, Decision Tree, Support Vector Machine[5], Random Forest[6][7][8][9][10]. In developing system for credit card fraud detection major challenge faced is in handling data imbalance. Data imbalance refers to the data in which there is significant difference in number of samples in different classes. Credit card data set which is available with kaggle [11] and used by most of the research studies is highly imbalanced meaning number of samples which are fraudulent are comparatively far less than legitimate transactions. In [6] provides detailed study of classification of unbalanced datasets. Mostly unbalanced datasets are common in medical diagnosis, fraud detection applications, spam filtering. In [7] different sampling techniques like Undersampling and Oversampling[15][12] ,SMOTE[13],SMOTETOMEK[14][15] ,Hybrid Undersampling and Oversampling[16] and other similar kind of techniques have been reviewed along with machine learning classifiers. Various Bagging and Boosting algorithms like XGBOOST[17][18][19], ADABOOST[20] , catBoost [21] , Boosting mechanism with spiral oversampling technique [22] have been used. In [23]using Support Vector Data Description machine learning model is built to improve the performance. In [24]Adversary based oversampling technique is used to deal with data imbalance. In [22][25] study provides comparison of various machine learning techniques is provided. In credit card fraud detection systems feature selection and dimensionality reduction is one of the major step. Various techniques like Principal Component Analysis[26], Swam Intelligence [27] , Genetic algorithm[28] have been used for this.

Deep learning techniques have more potential then Machine learning techniques. Wide range of applications in healthcare, financial sector from image/video classification to clustering problems can be solved using deep learning. DNN can automatically learn from complex and hierarchal features of raw data, can capture intricate patterns that may be challenging for traditional methods to detect. DNNs can perform End to End Learning eliminating need for extensive manual feature Engineering. In[29][30] Artificial Neural network is used in credit card fraud detection. In [31][32] the study uses Multilayer Perceptron .In [33][34][35] study proposes use of Convolutional neural Network, Homogeneity oriented Behavior Analysis and Deep Belief networks. It was found that performance of these techniques significantly decreases on unseen data. In[36][37]study proposes use of Auto Encoders and Deep Convolutional Neural Networks. In LSTM[38][39] with integration of SMOTE is proposed in[40].Some of the recent studies have proposed Generative Adversarial Network based approach [41][42] .Multiple datasets that have been used in various studies are Brazilian dataset[43] ,Taiwan dataset[44] ,Online Payment dataset (Kaggle)[45],Malaysian dataset[46] and European data set [47]. Most of the studies have used European data set which is highly imbalanced.

Metrics used are AUC, Accuracy, Recall Precision[48][49]along with this G-mean [50] BCR,BER[51] , MCC,FPR,FNR [52][52] to evaluate the performance.

Study Hypothesis

- The implementation of an Ensemble Deep Learning-based classification technique for credit card fraud will lead to a significant improvement in the accuracy of identifying fraudulent transactions.
- The integration of Deep Learning models will result in enhanced precision, recall, and F1-measure performance for detecting fraudulent credit card transactions, thereby minimizing both false positives and false negatives.
- The application of Deep Learning techniques significantly advances the detection of fraudulent credit card transactions by capturing intricate patterns and anomalies.

Research Methodology

Wide range of applications like from image/video classification to healthcare use Deep learning architectures. Classification, Clustering, Regression problems can be solved using Deep learning techniques. Based on the survey done complex problems can be solved using Deep Learning architectures such as feeding forward Neural Networks (Bebis and Georgiopoulos,1994), Convolutional Neural Networks (Collobert and Weston, 2008),Recurrent neural Networks (Yu et al., 2019).Proposed model will create a single yet powerful model by Combining advanced deep neural network models which can be referred to as Ensemble model. Most commonly used Ensemble techniques include averaging , Bagging , Boosting , Stacking. After applying these methods performance will be evaluated for credit card fraud detection.

Following Figure 2 shows possible flow based on the assumptions of proposed architecture

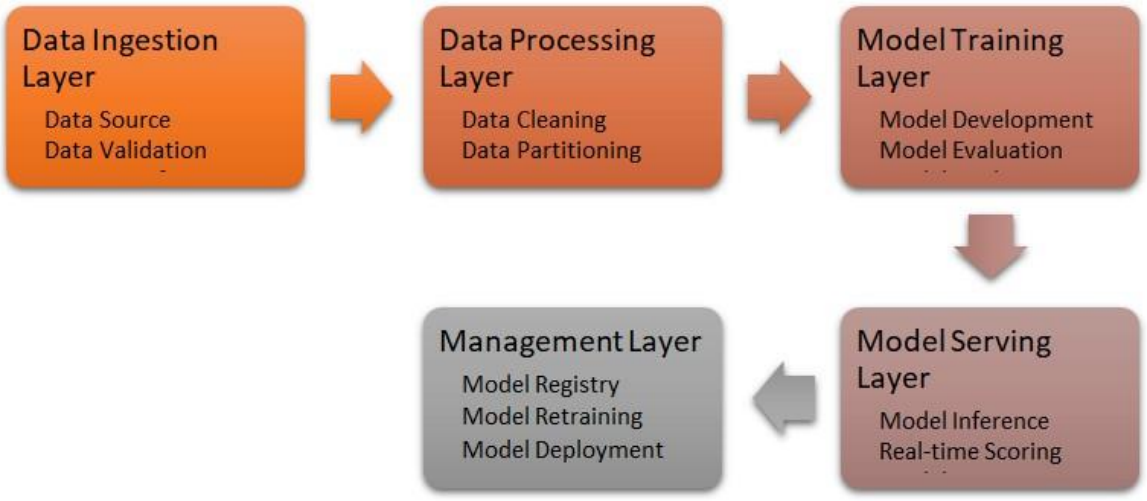

Figure 2: Possible Flow based on assumptions of proposed architecture

Data Ingestion Layer : This layer will handle the incoming data stream from various sources (e.g., APIs, databases, message queues).It ensures data quality and consistency and convert data into a suitable format for the model (e.g., time series, feature vectors).

Data Processing Layer : This layer will create additional features based on domain knowledge. It will perform data cleaning tasks like handling missing values and outliers. Then it will Split data into training, validation, and testing sets.

Model Training Layer This layer will build and train the GAN and LSTM model, potentially using hyperparameter tuning. Will assess model performance using relevant metrics and will Prepare the model for deployment.

Model Serving Layer : This layer will perform the task of deploying the trained model to a serving platform. It will also perform realtime scoring by processing incoming data and generate predictions.It will Track model performance and identify anomalies.

Model Management Layer: Model Registry will be the main function of this layer by Storing and managing different versions of the model. Model Retraining will be done periodically or based on performance degradation. Model Deployment will be done by Coordinating model deployment to the serving layer.

Proposed Architecture

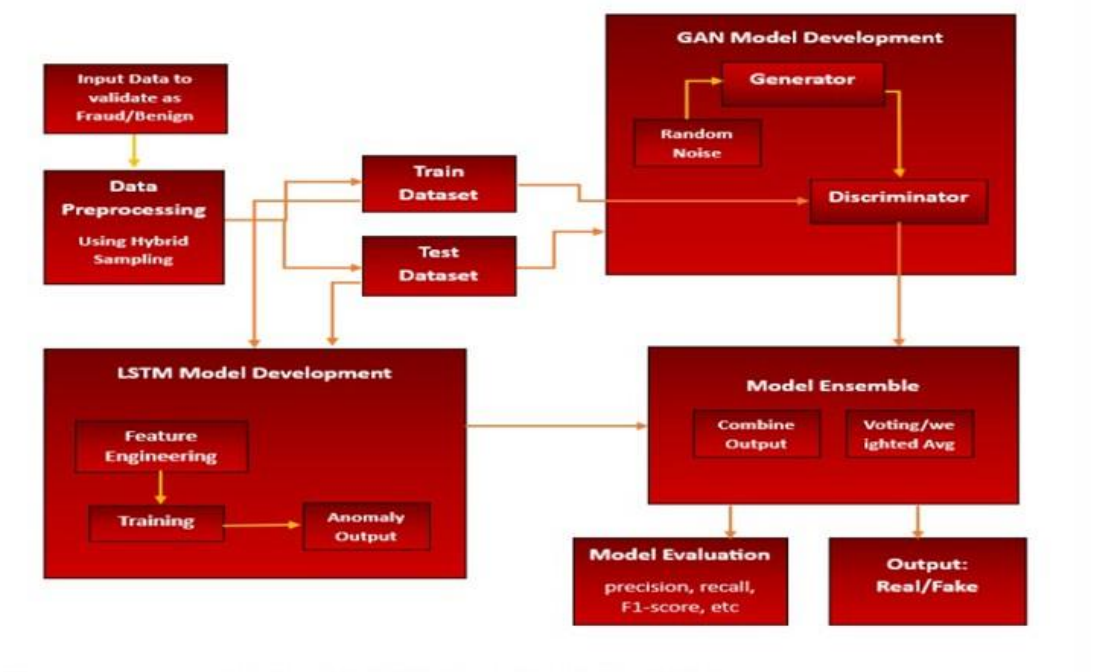

Figure 3: Proposed architecture

Our system proposes architecture shown in figure 3. Two major components will be used in this architecture are GAN model Development and LSTM model development. Generator will produce synthetic fraudulent transactions. It will be a feedforward neural network with multiple dense layers. Activation Functions will be applied to ensure the output values are within a certain range. Discriminator will distinguish between real and synthetic fraudulent transactions . Recurrent neural networks (RNNs) of the Long Short-Term Memory (LSTM) type are particularly well-suited for sequence prediction tasks, which can be adapted for binary classification tasks. Combination point is where the GAN and LSTM approaches are combined. Trained generator will be used to create synthetic fraudulent transactions.Ensemble techniques (voting, weighted averaging etc)would be applied to improve the performance.All standard metrics would be applied to evaluate the performance.

One of the most popular dataset is Kaggle's Credit Card Fraud Detection Dataset. It contains transactions made by European cardholders in September 2013, with 492 frauds out of 284,807 transactions. The dataset is highly imbalanced, with fraudulent transactions representing only 0.172 % of all transactions.This data set will be used for research purpose.

Expected Outcomes

- Insights gained from the study can lead to Identify various issues in Fraud dectection and the development of more sophisticated fraud detection model which will leverage advanced Deep Learning techniques and Strategies.
- The study aims to develop and validate an ensemble models that can accurately distinguish between fraudulent and legitimate credit card transactions. The primary outcome is an increase in detection rates of fraudulent activities while minimizing false positives, thereby enhancing the overall effectiveness of fraud prevention systems .
- The expected outcome of the proposed technique will be achieved in form of different performance matrix parameter accuracy, recall, precision and f1-score.

Conclusion

Credit cards have become increasingly popular since they may be used to save money and provide convenience. The widespread use of credit cards has led to an increase in fraud of all kinds. In the banking sector, credit card fraud has grown to be a serious issue. Merchants and the financial sector suffer significant monetary losses as a result.It is now difficult to identify these kinds of forgeries early on. Early credit card fraud detection can be achieved through the use of a variety of techniques.Deep Learning techniques have potential as they can perform end to end learning eliminating need for manual feature engineering.As fraudsters are finding new techniques it is required to develop system that will identify frauds and thereby enhance overall effectiveness of fraud prevention system.

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